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APPARATUS AND MEANS FOR UPDATING A MEMORY DISPLAY

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APPARATUS AND MEANS FOR UPDATING A MEMORY DISPLAY

FIELD OF THE INVENTION

The present invention relates to an apparatus for updating memory
5 displays.

BACKGROUND OF THE INVENTION

Retail stores offer goods for sale and need to provide customers
with information on item pricing. Price labels typically provide information
describing an item, the price for that item, and a machine readable code for the
10 item, typically in UPC bar code format. The price of items often changes rapidly,
requiring that printed retail labels be manually changed. Items that are on sale
often have a larger secondary label, called a shelf-talker, that highlights items on
sale for customers. The process of writing and changing retail pricing is costly,
primarily in the labor required to replace tags. Systems have been proposed to
15 address the problem of using digital data transmission to electrically changeable
retail labels known as Electronic Shelf Labels (ESL).

US 5,448,226, issued September 5, 1995 to Failing, Jr. et al.
describes an ESL system having a plurality of electronic price labels fitted into
rails. The rails provide power and communication to each label. Connection to
20 the rail can be provided through direct electrical connection to a conductor in the
rail or a radio frequency (RF) interface. The label can be powered though direct
electrical connection to power conductors in the rail, a battery or solar cell. Such a
system requires expensive complex electronic and communication structures.

US 6,186,555, issued February 13, 2001 to Rawlings describes
25 paper shelf-talkers that can be attached to conventional paper shelf labels to
identify items on sale. Adhesive strips are applied to a perforated substrate that is
printed to align text with the adhesive label. Attaching such a shelf-talker to a
label requires the assembly to be discarded when pricing is changed. US
5,771,005, issued June 23, 1998 to Goodwin III describes an auxiliary electronic

display that can be attached to an electronic price label (sic). The auxiliary display acts as an electronic shelf talker to identify special prices on goods.

US 6,130,603, issued October 10, 2000 to Briechele provides a good reference for current Electronic Shelf Labels. Independent modules contain a
5 power supply, antenna and controller. The controller is attached to a conventional liquid crystal display that requires periodic refreshing to maintain an image. Displays in ESLs currently display data on simple seven segment numeric data. An internal power supply expends about half its power maintaining the display image and the other half of the power maintaining the RF link. Such displays
10 have limited display resolution, and must incorporate expensive and bulky controller and transmission electronics. Such displays further must incorporate a power supply which further increases cost and size.

US 5,751,257 issued May 12, 1998 to Sutherland shows an electronic shelf label having first and second substrates. Sutherland omits the
15 expensive controller and power portions of the ESL, using a programming device translated across a series of pins and to write segments of an electronic display formed between the two glass substrates. The Sutherland apparatus requires the device to be positioned at a specific initial position, and translate specific sequence and rate to update the shelf tag. The information displayed in the
20 Sutherland apparatus is limited to low resolution images .

There is a need therefore for an improved display system having a low cost rewritable shelf label with high resolution.

SUMMARY OF THE INVENTION

25 The need is met according to the present invention by providing a display system that includes a light writable display associated with an identification code and arranged to receive an image wise pattern of light to form an image on the display; a display writer for producing the image wise pattern of light for writing the image on the display; a scanner connected to the display
30 writer for sensing the identification code; and a processor linked to the scanner

and the display writer and responsive to the identification code for programming the display writer to write an image associated with the identification code.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 is a schematic view of a label writing system in accordance with the present invention;

 Fig. 2 is a partial perspective view of a display incorporated into a label in accordance with the present invention;

 Fig. 3 is a schematic sectional view of optical states of cholesteric
10 material in accordance with the present invention;

 Fig. 4 is a plot of the response of a polymer dispersed cholesteric material, originally in the planar state, to constant flash unit lamp energy and various voltages;

 Fig. 5 is a side view of a label in accordance with the invention;

15 Fig. 6 is a front view of a written label in accordance with the present invention;

 Fig. 7 is a schematic view of a label and a writer in accordance with the invention;

 Fig. 8 is a schematic view of a writer employed with the present
20 invention;

 Fig. 9 is a schematic view of a writer scanning an object identity code according to the present invention;

 Fig. 10 is a schematic view of a writer obtaining label information for a specific object identity code from a central processor using wireless
25 transmission according to the present invention; and

 Fig. 11 is a schematic view of a writer writing a display using label information for a specific object according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 is a schematic view of a label writing system in accordance with the present invention. A label **19** displays information about an object **100**. Objects **100** can be objects for retail sale or inventory items. Objects **100** have an associated object identity code **102**. The code **102** can be attached to individual items or adjacent to a set of one or more objects. Scanner/writer **80** contains means to scan an identification code **102** and write label **19**.

Scanner/writer **80** has means to scan an object identity code **102** and select label image data for label **19** associated with a specific object **100**. Scanner/writer **80** further contains memory means to create label image data associated with an identification code **102** or access such data via writer antenna **88** to retrieve label image data from a central processor **90** using a conventional wireless network. Central processor **90** receives requests for label image data from processor antenna **92** from the wireless network. Central processor **90** retrieves label image data from central memory **94**, and transmits the data via processor antenna **92** to the scanner/writer **80** that made the request.

Fig. 2 is a perspective of a display incorporated into a label in accordance with the present invention. Display **10** includes a flexible display substrate **15**, which is a thin transparent polymeric material, such as Kodak Estar film base formed of polyester plastic that has a thickness of between 20 and 200 microns. In an exemplary embodiment, display substrate **15** can be a 125-micron thick sheet of polyester film base. Other polymers, such as transparent polycarbonate, can also be used.

A first conductor **20** is formed on display substrate **15**. First conductor **20** can be tin-oxide, indium-tin-oxide (ITO), or a transparent organic conductor such as polythiophene, with ITO being the preferred material. Typically the material of first conductor **20** is sputtered or coated as a layer over display substrate **15** having a resistance of less than 1000 ohms per square. First conductor **20** can also be formed by printing a transparent organic conductor such as PEDT/PSS, PEDOT/PSS polymer, which materials are sold as Baytron® P by

Bayer AG Electronic Chemicals. A portion **22** of first conductor **20** does not contain subsequent layers to provide exposed first conductor.

Cholesteric liquid crystal light modulating layer **30** overlays first conductor **20**. Cholesteric liquid crystal light modulating layer **30** contains
5 cholesteric liquid crystal material, such as those disclosed in US Patent 5,695,682 issued December 9, 1997 to Doane et al., the disclosure of which is incorporated by reference. Such materials are made using highly anisotropic nematic liquid crystal mixtures and adding a chiral doping agent to provide helical twist in the planes of the liquid crystal to the point that interference patterns are created that
10 reflect incident light. Application of electrical fields of various intensity and duration can be employed to drive a chiral nematic material (cholesteric) into a reflective state, to near transparent state, or an intermediate state. These materials have the advantage of having stable optical states in the absence of an electrical field. The materials can maintain a given optical state indefinitely after the field is
15 removed. Cholesteric liquid crystal materials can be formed using a two component system such as MDA-00-1444 (undoped nematic) and MDA-00-4042 (nematic with high chiral dopant concentrations) available from E.M. Industries of Hawthorne, N.Y.

In a preferred embodiment, cholesteric liquid crystal light
20 modulating layer **30** is a cholesteric liquid crystal dispersed in de-ionized photographic gelatin. The liquid crystal material is mixed at 8% cholesteric liquid crystal in a 5% gelatin aqueous solution. The mixture is dispersed to create an emulsion having 8-10 micrometer diameter domains of the liquid crystal in aqueous suspension. The domains can be formed using the limited coalescence
25 technique described in US 6,423,368 issued July 23, 2002 to Stephenson et al. The emulsion is coated over first conductor **20** on a polyester display substrate **15** and dried to provide an approximately 9-micrometer thick polymer dispersed cholesteric coating. Other organic binders such as polyvinyl alcohol (PVA) or polyethylene oxide (PEO) can be used in place of the gelatin. Such emulsions are
30 machine coatable using coating equipment of the type employed in the

manufacture of photographic films. A gel sub-layer can be applied over first conductor 20 prior to applying cholesteric liquid crystal light modulating layer 30 as disclosed in US 6,423,368 referenced above.

Fig. 3 is a schematic side sectional view of a chiral nematic material in a planar and focal conic state responding to incident light. In the figure on the left, after a high voltage field has been applied and quickly switched to zero potential, the liquid crystal molecules become planar liquid crystal 72, which reflect portions of incident light 60 as reflected light 62. In the figure on the right side of Fig. 2, upon application of a lower voltage field, the molecules of the chiral nematic material break into weakly forward scattering cells known as focal conic liquid crystal 74. Increasing the time duration of a low voltage pulse creates optical states between reflective planar liquid crystal 72 and light scattering focal conic liquid crystal 74.

A light absorber 35 is positioned on the side opposing the incident light 60. Light absorber can be dark second conductor 40. Light absorber 35 can be a thin layer of light absorbing, sub-micron carbon in a gel binder as disclosed in US 6,639,637 issued October 28, 2003 to Stephenson. As fully evolved focal-conic liquid crystal 74, the cholesteric liquid crystal is forward light scattering and incident light 60 is absorbed by light absorber 35 to create a black image. Progressive evolution towards the focal-conic state causes a viewer to perceive reflected light 62 that transitions to black as the cholesteric material changes from reflective planar liquid crystal 72 to a fully evolved light scattering focal-conic liquid crystal 74. When the field is removed, cholesteric liquid crystal light modulating layer 30 maintains a given optical state indefinitely. The states are more fully discussed in US 5,437,811 issued August 1, 1995 to Doane et al.

Fig. 4 shows a plot of the response of a polymer dispersed cholesteric material, originally in the planar state, to constant flash unit lamp energy and various voltages. The curve for the masked material (filled boxes) is the same response of materials in the absence of the thermal pulse provided by flash unit 82. The clear curve is the same display in the presence of the heat pulse

from the flash unit combined with an electrical field. Hysteresis between the masked and unmasked curves, at approximately 20 and 60 volts are two conditions that permit writing of displays using a combination of light and electric field. Many operating states can be found to write displays. Such states are more
5 thoroughly discussed in copending USSN 10/256,930 filed September 27, 2002 by Stephenson et al. The combination of high intensity light under an electric field permits high resolution images without patterning conductors. The process eliminates the need for many drives on many conductive traces.

Returning to Fig. 2, second conductor 40 overlays or can be light
10 absorber 35. Second conductor 40 has sufficient conductivity to provide an electric field between the first transparent conductor 20 and second conductor 40 strong enough to change the optical state of the cholesteric material in cholesteric liquid crystal light modulating layer 30. Second conductor 40 can be formed, for example, by the well known technique of vacuum deposition for forming a layer
15 of conductive material such as aluminum, tin, silver, platinum, carbon, tungsten, molybdenum, tin or indium or combinations thereof. The layer of conductive material can be patterned using well known techniques of photolithography, laser etching or by application through a mask.

In a preferred embodiment, second conductor 40 is formed by
20 screen printing a conductive ink such as Electrodag 423SS screen printable electrical conductive material from Acheson Corporation. Such screen printable conductive materials comprise finely divided graphite particles in a thermoplastic resin. Screen printing is preferred to minimize the cost of manufacturing the display. The light absorbing properties of the printed carbon material reduces the
25 need for light absorber 35.

The presence of light absorber 35 permits second conductors to be formed of reflective materials. Second conductors 40 can be formed of metal, for example, by vacuum deposition of conductive materials such as aluminum, chrome or nickel. Second conductors 40 are formed by screen printing a reflective
30 and conductive formulation such as UVAG© 0010 from Allied Photochemical of

Kimball, Michigan. Such screen printable conductive materials comprise finely divided silver in ultra violet curable resin. After printing, the material is exposed to ultra violet radiation greater than 0.40 Joules/cm², the resin will polymerize in 2 seconds to form a durable surface. The fast cure process time is advantageous in manufacturing.

Alternatively, second conductors 40 can be formed by screen printing thermally cured silver bearing resins. An example of such a material is Acheson Electrodag® 461SS, a heat cured silver ink. In the case of reflective second conductor 40, light absorber 35 can be used as a light absorbing layer that provides alternative colors, as described in copending USSN 10/455,050 filed June 5, 2003 by Stephenson et al.

The use of a flexible support for display substrate 15; unpatterned first conductor 20; machine coated cholesteric liquid crystal light modulating layer 30; and unpatterned second conductor 40 permits the fabrication of a low cost flexible display. The opto-electrical writing process eliminates the need for attached, expensive electronics. Small displays according to the present invention can be used as electronically rewritable tags for inexpensive limited rewrite applications.

Fig. 5 is a side view of a label 19 in accordance with the invention. Display support 17 carries a display 10. Display support 17 can be a sheet of material having printed support contacts 16. Display support 17 can be made of paper or white plastic and can have an area to carry printed information. Two support contacts 16 are positioned under first conductor 20 and second conductor 40 respectively, and extend outside the perimeter of an attached display 10. A display 10, formed in accordance with Fig. 4 is positioned over support contacts 16 and bonded to display support 17 so that support contacts 16 provide an exposed electrical connection to display 10. In a preferred embodiment, an anisotropic adhesive, such as 3M 9703 Electrically Conductive Tape is used, which permits electrical conduction through an adhesive but not across the adhesive.

Anisotropic adhesives consist of a conductive particle having a diameter near the thickness of adhesive binder, and dispersed at a concentration that does not conduct laterally. When display 10 is pressed onto support contacts 16, conductive particles form an electrical connection between conductors on the back of display 10 and support contacts 16. The adhesive can be thermally cured with an applied pressure to provide a permanent connection between conductors on the back of display 10 and support contacts 16.

Fig. 6 is a front view of a label in accordance with the present invention. Two support contacts 16 are exposed for front connection of an electric field to first conductor 20 and second conductor 40 within display 10. The use of a flexible display support 17 and display 10 permit printing into areas of label 19. An additional area of display support 17 is free of display 10 to permit writing of printing 14 on display support 17.

Ink jet printers are useful in this application because ink jet print heads are spaced from a dye receiving surface by about 1.00 millimeter. Display 10 is typically less than 0.25 millimeters thick and is flexible, permitting display assembly 17 to pass through an ink jet printer and not interfere with the motion of an ink jet head over display assembly 17. Display support 17 can further include and adhesive backing and release liner. Such structures are more thoroughly discussed in copending USSN 10/134,185 filed April 29, 2002 by Stephenson et al.

Fig. 7 is a schematic view of a label and light writer used with the present invention. Writer controller 81 acquires image data corresponding to an image to be printed on display 10. Masking display 83 receives image data from writer controller 81 and creates an image wise pattern of light transmitting and light blocking areas that correspond to the desired image pattern. Masking display 83 can be a simple twisted-nematic (TN) or super-twisted-nematic (STN) liquid crystal display of conventional design. Pixels on masking display 83 can be formed in an array of uniform pixels, or contain electrodes patterned to conform to types of specific images, such as seven segment digital images. Writer controller

81 provides an electrical field to writer contacts 86 which are pressed against support contacts 16 to provide an electrical field to display 10. Flash unit 82 is triggered by writer controller 81 in conjunction with application of the electrical field to form a pattern wise image on display 10 using masking display 83. By
5 using the masking display to write onto a simple unpatterned label, an image having the higher resolution of the masking display can be provided on the label without the need for complex electrode structures in the label and corresponding contacts in the writer, thereby significantly reducing the cost of the label.

An example of a display useful as a masking display in the present
10 invention is a dot-matrix super-twisted-nematic (STN) display, part number TM 13164 BCHG-1 from Tianma Corporation in Taiwan. The display has an array of 63 by 131 pixels at a 0.50 mm pitch. The display has a 4:1 contrast ratio, which provides modulation of high intensity light sufficient to create an image-wise pattern of high intensity light across display 10.

15 Fig. 8 is a schematic view of a hand held scanner/writer 80 used with the present invention. As shown in Fig. 9, scanner 84 in scanner/writer 80 can determine an object identification code 102. Scanner 84 can be a conventional bar code reader that can read a bar code from an object to determine the object identification code. Alternatively, scanner 84 can be an radio frequency (RF) tag
20 scanner that retrieves object identification code 102 from an object having an attached RF data storage element. Writer controller 81 can contain internal memory means that provides a label image for one or more object identification codes 102, or can use writer antenna 88 to access label data wirelessly from an external data source. Scanner/writer 80 further incorporates flash unit 82 to
25 provide high intensity light. High intensity light emitted by flash unit 82 is masked by a masking display 83 connected to writer controller 81. Writer contacts 86 are connected to writer controller 81 to permit application of an electric field in conjunction with flash unit 82 to electro-optically writer data image associated with object identification code 102 to display 10.

Fig. 9 is a schematic view of the scanner/writer scanning an object identity code. Writer controller is activated to acquire an object identification code **102**. Object identification code **102** can be received as an optical or radio signal from storage means attached or unattached to object **100**. Fig. 10 is a
5 schematic view of the scanner/writer **80** obtaining label information for a specific object identity code **102** from a central processor **90** using wireless transmission. Writer controller **81** obtains an object identification code **102** as shown in Fig. 9 and transmits the object identification code **102** though a wire (not shown), or wirelessly through writer antenna **88**, to central processor **90**. Central processor
10 operates on the object identification code **102** to retrieve a label image from memory **94**. Image data can contain pricing information, date and time information, a quantity or location data. Central processor **90** can transmit the image data back to scanner/writer **80** wirelessly using processor antenna **92** to both receive and send data.

15 Fig. 11 is a schematic view of scanner/writer **80** imprinting display **10** using label information for an object identification code **102**. Writer controller **81** contains image data for an object identification code **102** and is prepared to write to label **19**. Scanner/writer **80** and label **19** are brought together using conventional means. In a first case, label **19** can be removed from a holder (not
20 shown) and inserted into the body of scanner/writer **80**. In a second case, scanner/writer **80** or portions containing flash unit **82**, masking display **83** and writer contacts **86** are pressed against label **19**. Contacts **85** of scanner/writer **80** are pressed against support contacts **16** to provide an electrical field to display **10**. Masking display **83** is brought into alignment with an area to be written onto a
25 display **10** attached to label **19**. Sensors connected to writer controller **81** can verify that the correct alignment has been made between label **19** and scanner/writer **80**.

Writer controller **81** first transmits image data corresponding to an image for object identification code **102** to masking display **83**. Writer controller
30 **81** then applies an electrical field across display **10** using writer contacts **86** and

fires flash unit **82** to imprint the label image on masking display **83** onto display **10**. Scanner/writer **80** can be disengaged from fixed labels, providing an inexpensive electrically rewritable ESL. A label **19** that has been removed from a holder can be disengaged from scanner/writer **80** and re-mounted onto the holder.

5 The method and apparatus of this invention provides low cost, simple and rapidly written shelf labels with high information content. The scanner/writer provides a simple and accurate means for identifying an object associated to be labeled and for retrieving an image for the label associated with the object. The labels are inexpensive, having a few simple, unpatterned, mass
10 produced layers. The writing apparatus itself is simple, requiring a low cost flash unit system, an inexpensive masking display and a 2 wire electrical exciter for the display **10**. Separating the drive from the display permits many inexpensive labels **19** to be written by a single, simple display writer **90**.

15 The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

PARTS LIST

10	display
14	printing
15	display substrate
16	support contacts
17	display support
19	label
20	first conductor
22	exposed portion of first conductor
30	cholesteric liquid crystal light modulating layer
35	light absorber
40	second conductor
60	incident light
62	reflected light
72	planar liquid crystal
74	focal conic liquid crystal
80	scanner/writer
81	writer controller
82	flash unit
83	masking display
84	scanner
86	writer contacts
88	writer antenna
90	central processor
92	processor antenna
94	central memory
100	object
102	object identification code